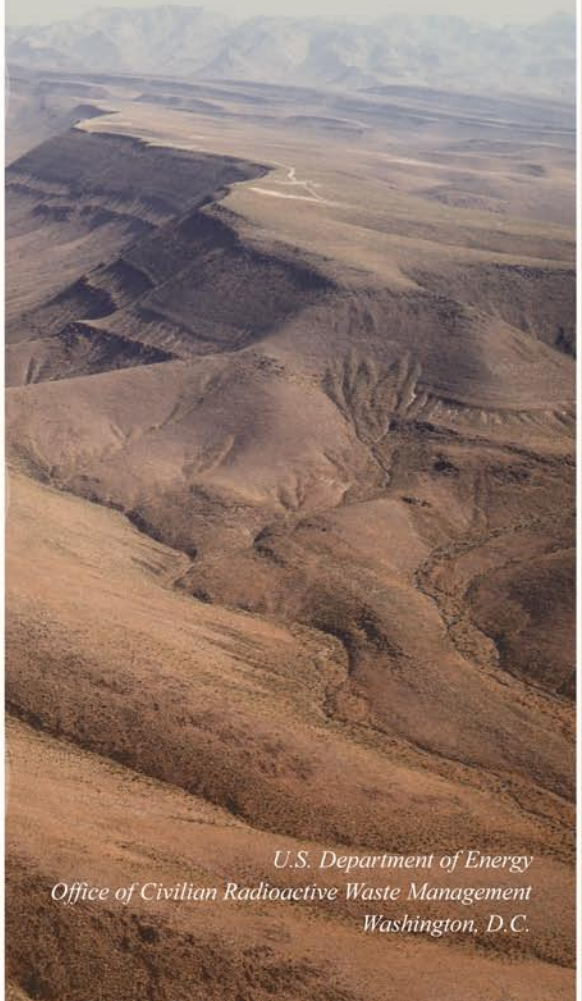
DOE/RW-0574

Office of
Science and Technology and International

Science and Technology Program Strategic Plan

November 2004

OST&I



U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Washington, D.C.

YUCCA MOUNTAIN PROJECT

Introduction - *Need for a Science and Technology Program*

Program Drivers

- Reduce Costs
- Enhance Understanding
- Promote Best Practices of the Nuclear Industry

The role of the Science and Technology program is to provide OCRWM with new knowledge and information on technological innovations, or improved scientific understanding or methods, in order to make available potential enhancements to construction, operation, or the function of the proposed repository. The Science and Technology program will advance technologies not previously considered, and will identify new or substantially revised scientific methods or tools to provide a better understanding of the repository environment. Its scope is intended to support repository surface and subsurface operations and performance as well as transportation activities.

Projects supported will meet at least one of the following three critical criteria established for the program.

- Reduce the costs and schedule of the repository system.
- Enhance understanding of the processes related to waste isolation at the repository.
- Keep OCRWM current with best practices in the nuclear industry.

Mission

"Provide advanced science and technology to continually enhance our understanding of the repository system and to reduce the cost and schedule for the OCRWM mission."

Vision

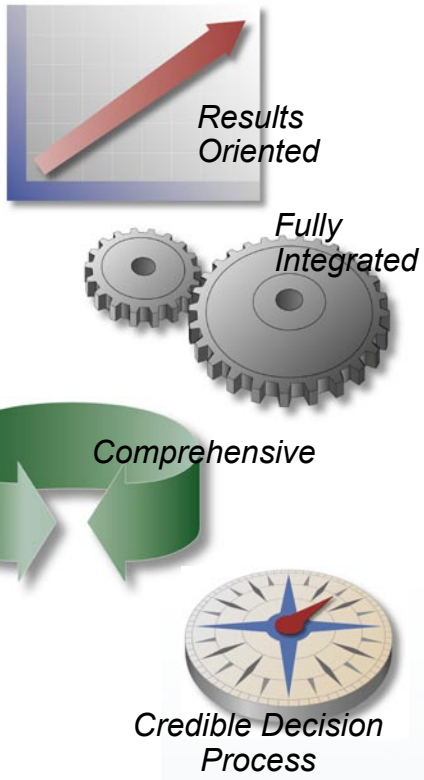
"OCRWM and the affected public will value the contributions that scientific and technological advances have made toward safer, more expeditious, and more cost-effective waste isolation."

Science and Technology contributions are critical to improving the efficiency and cost effectiveness of the repository system.

Values - *Foundation of the Strategy*

The fundamental values that guide science and technology activities are identified below. These values will ensure the program remains focused on the OCRWM mission:

- Results Oriented - Activities will be focused on potential advances that can significantly reduce the cost or schedule of the OCRWM mission while maintaining or enhancing performance.
- Integrated with the Repository System – Activities will be linked to program goals, and it is expected that financial accountability would transfer from the Science and Technology program to the repository system if technologies are implemented.
- Comprehensive in Scope - Activities will cover a wide range of science and technology (ranging from targeted applied research to technology development to technology demonstration, leading to technology deployment.)
- Credible and Open Decision Process - Processes used to establish priorities, set program and project direction, allocate funding, and select project teams are based on a clear set of criteria and are applied in an open, transparent manner.



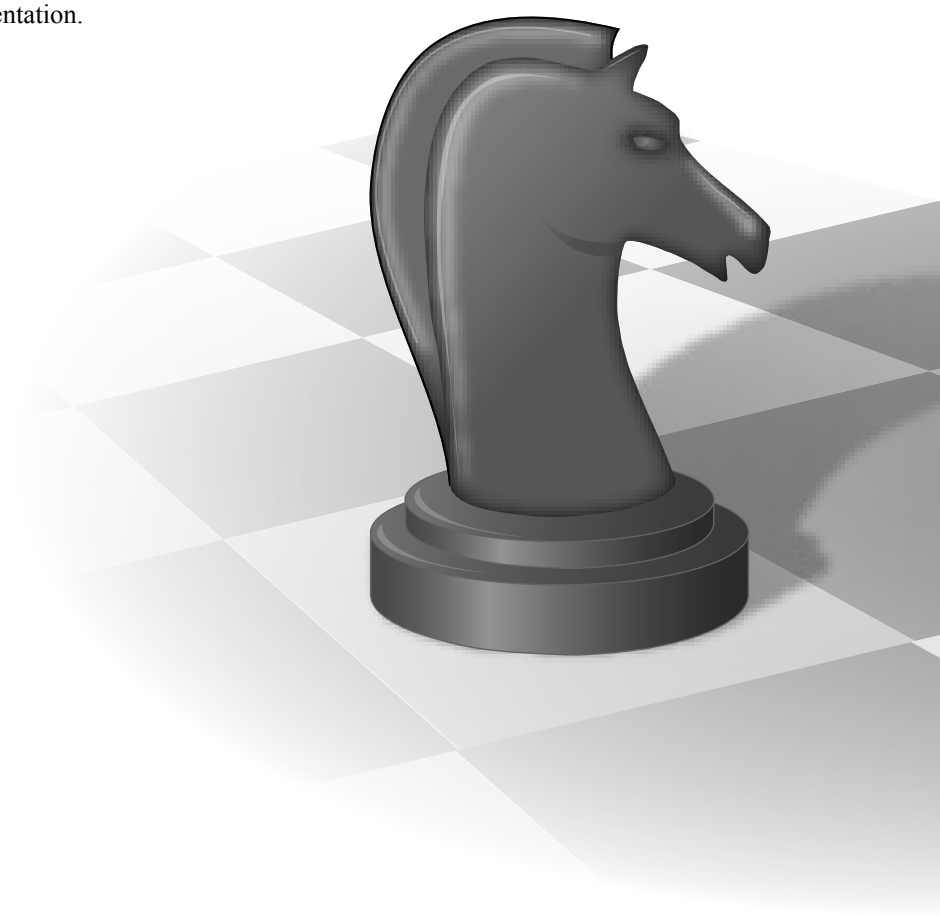
Key Assumptions

- The Science and Technology program is not directly involved with the repository line activities of design, safety, or licensing.
- Systems engineering studies will have sufficient detail to adequately support science and technology efforts to identify opportunities for the reduction of cost or schedule to accomplish the OCRWM mission.
- The performance of the Science and Technology Program will be measured as part of overall OCRWM performance.
- The Science and Technology program may pursue alternative approaches to a currently planned project. Such investigations will not be construed as a deviation from the current approach, but as the pursuit of improvements and advances.

- Success is defined as the acceptance of an alternative design or operational approach by the line program, or as an accepted change to an analysis associated with an increase in the understanding of a technical issue.
- It is understood that science and technology investments support future efforts, and that projects will be focused primarily on an alternative or “next generation” approach whose schedule will be targeted to an appropriate insertion point.

Strategic Approach - Implementing the Plan

- Identify Opportunities Using Systems Engineering and Technology Roadmapping – Comprehensive integrated systems approaches will be used to identify and define technology requirements and establish project performance measures. Technology roadmaps will be prepared for the highest-priority areas to provide a robust and credible basis for the science and technology investment portfolio.
- Employ Sound Business Practices –
  1. Selection criteria are focused on line program acceptance: Projects will be selected using a set of criteria that is focused on the integration of the resulting product with repository operations, to ensure the greatest impact to the OCRWM mission in terms of risk and cost reduction.
  2. Project management practices are enforced: Performance measures, milestones, and decision points will be established for each project prior to initiation and will be reviewed periodically.
  3. Relevance and technical merit are both required: Regular reviews will be held to ensure all projects meet quality requirements, are of the highest technical merit, and continue to meet the relevant repository requirements and schedule.
  4. Project completion point is defined: User requirements and the technology insertion points are defined, and each science and technology project will be transferred to the repository system prior to full scale prototype testing or other implementation.
- Collaborate with the Repository System – Activities will be coordinated with the repository system, from project planning, funding, and execution to the transfer of the results and implementation.



In collaboration with the repository system, Science and Technology will yield new knowledge and fully developed technologies to keep the repository current with the best practices in the nuclear industry.

- Fully Integrated with the Scientific and Vendor Community – Technology development and demonstration activities will be carried out by individuals from private industry, DOE sponsored laboratories, universities, and other federal agencies, leveraging work where appropriate with other relevant programs both foreign and domestic. For technologies that will be demonstrated through the commercial market, potential vendors will be identified early and may even become partners in development.
- Select Technology Providers Using Methods Appropriate to the Maturity of the Activity - Scientific activities will generally be competed among the DOE laboratories, universities, or other federal agencies on a periodic basis, while more mature requirements will be solicited to private industry. Industry procurements will typically use a phased approach that allows multiple concepts to be competitively developed and evaluated prior to selection.
- Promote Expert Collaboration - Thrust Teams led by individuals from DOE sponsored laboratories, other government agencies, universities, or the private sector will be established to manage and coordinate projects within each major program area.
- Co-fund Prototype Testing – For projects beyond the development stage, work should generally be co-funded with the repository system and must meet relevant OCRWM quality assurance requirements.
- Conduct Frequent Review - Peer review will be performed on all projects periodically to ensure the projects are meeting the OCRWM quality assurance requirements, are of high technical merit, and are meeting program needs and schedules.

Strategy

- Employ sound business practices
- Be an integrated partner and contributor
- Contribute to and fully integrate with the repository system
- Add value and knowledge through collaboration with experts
- Define project end point and requirements prior to initiation
- Transparent review process

Investment Areas - *Building for the Future*

The opportunities for investment in science and technology are typically identified by systems engineering and planning activities performed by other offices within OCRWM, by the knowledge developed by project experts in the normal course of their work, or by outsiders familiar with the OCRWM mission. Investments occur in both science and technology. While there is a clear driver as to the need to bring new technology to the high-cost-center activities within OCRWM, the value of advancing science (such as providing new knowledge to better understand processes like waste-form performance or natural barriers) is often difficult to explain. The goal is to achieve a sustainable balance of investments between these two types of activities. The distribution of investments will vary annually. One area of program emphasis will focus on the rapid insertion of improved technology into repository design and operations. In addition, activities that require long-term study, such as waste form performance or natural barriers, will be maintained at an appropriate level to assure that the understanding of the systems associated with the repository continues to grow.

Waste Package Technology

Approximately 11,000 waste packages need to be fabricated in order to dispose of the 70,000 metric tons of waste to be placed in the repository. Each of these waste packages will be made of a structural stainless steel inner container surrounded by an outer shell made of a highly corrosion-resistant metal alloy. The fabrication of these waste packages requires precision machining, welding, and precise alignment of two concentric metal containers and three lids. As a result of the high cost of materials and of complex fabrication, the cost of each waste package is over $600,000, leading to a total of over $8 billion in life-cycle costs. Waste package fabrication is the second largest cost of the repository system . Improvements in understanding corrosion, simplifying the manufacturing process, improving fabrication, and better non-destructive testing could significantly reduce this portion of the overall repository cost.

Subsurface Operations

One of the largest overall costs for the repository is estimated to be subsurface operations at nearly $7 billion. Subsurface operations consist of tunneling more than 100 km of underground openings, keeping these openings open, ventilation, waste package emplacement, and monitoring. Several opportunities exist to reduce this cost. Tunneling will be relatively slow and challenging, due to the properties of the tuff and the need to maintain the underground tunnels open for at least 50 years. Similarly, emplacement and maintenance, which would normally be a standard operation, will be made difficult by the fact that once waste packages are placed in a tunnel workers will no longer be permitted in the area. Robotic or remote material handling and monitoring tools, remote sensors, and long-term power sources for efficient operation can be improved, and will need to be improved as technology advances.

Surface Operations

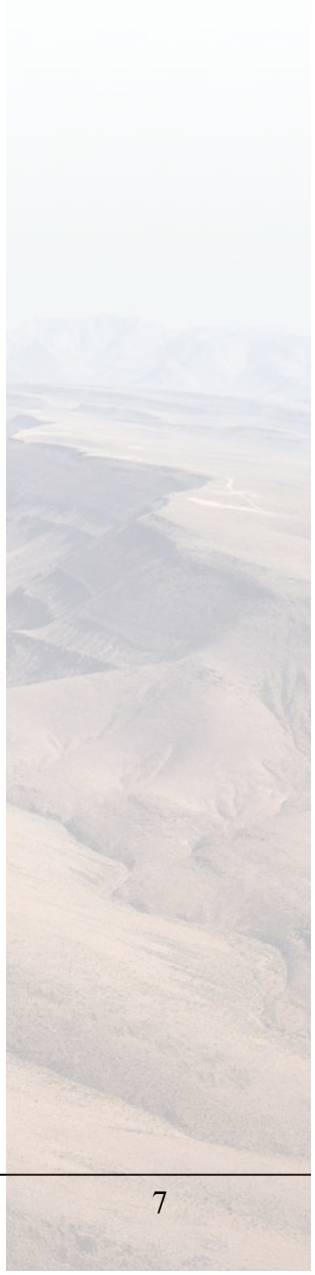
Surface operations refers primarily to the production buildings located near the repository entrance portal that house the systems and components used to receive, prepare, and package the waste before underground emplacement. Radioactive operations will be performed in all the major surface facilities. Each facility is being designed to receive, process, and package a specific waste type. The reinforced concrete walls surrounding the waste processing portions of these buildings are extraordinarily thick, to provide shielding for workers during and after a large earthquake. The life-cycle cost of the surface facilities is almost $8 billion to construct and operate. The cost of these facilities is driven by their robust nature, due to predicted seismic conditions, and by the need for the remote handling and monitoring of the radioactive material. Research opportunities exist associated with the seismic conditions at the site, and with more efficient use of robotic or advanced autonomous material handling processes. Advanced technical work in these areas may reduce the overall cost of surface operations.

Post-Closure Performance

The post-closure performance of the proposed Yucca Mountain repository is determined by the natural and engineered barriers, that work together to prevent, delay, and mitigate the consequences of any radioactivity released from the waste packages. The natural barriers at Yucca Mountain are an important part of the overall system to prevent radioactive materials from reaching the accessible environment. The natural characteristics of the climate, the soil, unsaturated rock formations, and volcanically deposited rock layers work together to contain and isolate the waste. A major part of the characterization phase of the Yucca Mountain Project was devoted to understanding the characteristics of these natural barriers and to developing an analysis model that describes how they will work together for many millennia in the future. The waste form itself is one of the engineered "barriers" that will provide, in conjunction with the natural barriers, the repository's ability to limit doses in the accessible environment to levels below applicable regulatory standards. The behavior of the total repository system (the combined effect of all of the barriers) has been analyzed and found to be adequate for the purpose of meeting these standards. However, the analysis model uses many conservative simplifications of the natural barriers, and models the waste form's degradation and the mobilization of soluble radionuclides as occurring more rapidly than experts believe is realistic for repository-relevant conditions. Consequently, investigations to better understand aspects of the natural processes in the subsurface and the behavior of the waste form will improve the fidelity of the calculated long-term performance of the repository.

Performance Monitoring, Confirmation, and Closure

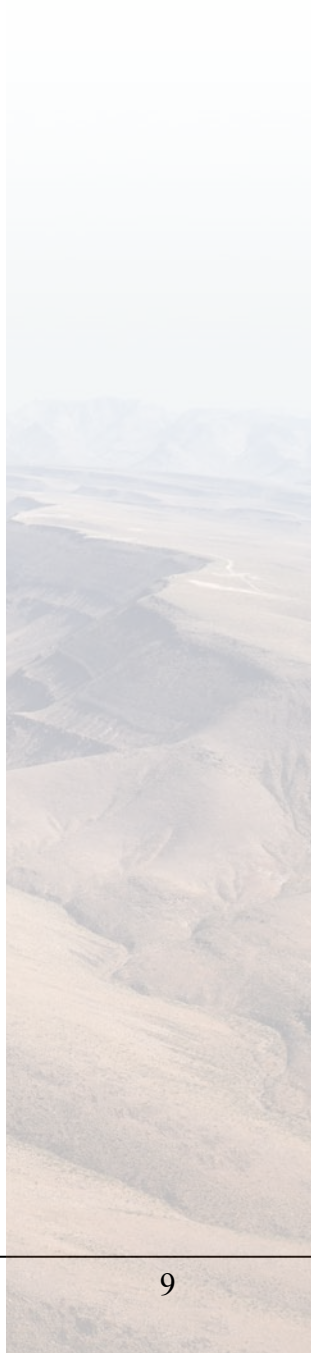
Ensuring public safety requires continued stewardship, including a program for evaluating new information obtained during the construction and operation of the repository. Performance confirmation is a set of analyses, measurements, and tests required by the United States Nuclear Regulatory Commission whose objective is to confirm that the actual performance of the repository's systems conforms to what is expected. Other test and monitoring activities are also planned outside of the formal Performance Confirmation program. The focus of all of this work is to gather and analyze data on conditions and systems that will affect the performance of the facility after closure, and to evaluate their impacts on post-closure performance. Because this is such a long-term activity, there are ample opportunities to reduce its cost through the application of innovative sensor technology, conducting investigations that reduce the uncertainty in repository performance estimates.



Science and Technology Strategic Goals

Science and Technology goals support higher-level OCRWM Strategic goals. The goals and performance indicators shown in the table below will be used to measure the overall performance of the Science and Technology program. Distinct milestones and measures supporting each science and technology initiative will be established and will be used to measure performance annually.

Goal	Performance Indicator
Reduce total life-cycle costs through the insertion of new technology and knowledge into the Yucca Mountain Project	Reduced cost of engineered barriers • Improve waste package fabrication methods and materials **Reduced cost of subsurface tunneling** • Enhance silica dust suppression • Demonstrate advanced roof support and construction materials compatible with the proposed repository environment • Demonstrate improved tunneling methods **Reduced cost of material handling** • Enhance throughput and efficiency of remote material handling
Advance scientific and technical understanding of the proposed Yucca Mountain Repository	**Improved understanding of post-closure performance** • Demonstrate that natural barriers significantly enhance the defense-in-depth waste isolation processes • Enhance understanding of processes controlling radionuclide releases from the waste package • Enhance understanding of the processes and the environments controlling the corrosion of the waste packages • Identify potential radionuclide absorber (getter) materials and engineer the materials into an appropriate form for deployment **Improved the capability for long-term testing, monitoring, and analysis** • Enhance and/or develop new sensors suited to the high heat and radiation requirements of a repository environment



Contacts

This publication was produced by the U.S. Department of Energy Office of Civilian Radioactive Waste Management (OCRWM)

For further information, contact:

U.S. Department of Energy

Office of Civilian Radioactive Waste Management

Office of Science and Technology and International (RW-40E)

1000 Independence Avenue, SW

Washington, D.C. 20585

For additional copies, call: 1-800-225-6972

or write:

1551 Hillshire Drive

Las Vegas, Nevada 89134-6321

or visit The OCRWM Home Page:

http://www.OCRWM.DOE.gov